# Radioactivity in the Surface Air at BRW, MLO, SMO, and SPO During 1993

#### RICHARD J. LARSEN AND COLIN G. SANDERSON

Environmental Measurements Laboratory, U.S. Department of Energy, New York 10014-3621

## INTRODUCTION

High-volume air filter samples are routinely collected by CMDL personnel at BRW, MLO, SMO, and SPO for EML's Surface Air Sampling Program (SASP). The primary objective of this program is to identify and study the temporal and spatial distribution of specific anthropogenic and natural radionuclides in the lower troposphere. The naturally occurring radio-nuclides  $^{7}$ Be and  $^{210}$ Pb are of particular interest since they serve as excellent tracers for air masses of upper and lower tropospheric origin. Beryllium-7 ( $T_{1/2} = 53.2$  d) is produced by cosmic-ray interactions in the upper troposphere and the stratosphere, and  $^{210}$ Pb ( $T_{1/2} = 22.3$  years) is a decay product of  $^{222}$ Rn, a noble gas that diffuses from soils.

### MATERIAL AND METHODS

Weekly air filter samples are continuously collected using Dynaweb filter material. The air samplers move ~1700 m³ of air per day through a 20.3-cm diameter filter. The weekly filter samples collected at BRW and MLO are analyzed by gamma-ray spectrometry using a high-purity germanium (HPGe) detector with a 1.5-cm diameter well. The individual weekly samples from SMO and SPO are not routinely analyzed. Monthly composite samples for each site are formed

by adding together one half of each of the weekly filter samples. These monthly composite samples are compressed into 45-cm<sup>3</sup> plastic planchets and are routinely analyzed for several gamma-ray emitting radionuclides using either n-type low-energy coaxial, HPGe detectors or p-type coaxial high-resolution, germanium lithium or HPGe detectors. Detailed information on SASP is periodically published [*Larsen and Sanderson*, 1991].

#### RESULTS

The results of the analyses of several radionuclides and the total gamma-ray activities for the monthly composite samples from filters collected at BRW, MLO, SMO, and SPO during 1993 are reported in Table 1. The total gamma-ray activities are reported in units of counts per minute (cpm) per cubic meter of sampled air referenced to 15°C and 1 Atm. The surface air concentrations of <sup>7</sup>Be and <sup>210</sup>Pb are reported in millibecquerels (mBq) per standard cubic meter of air, and <sup>95</sup>Zr, <sup>137</sup>Cs, and <sup>144</sup>Ce are reported in microbecquerels (μBq) per cubic meter of air referenced to 15°C and 1 Atm. The concentrations are reported as corrected for radioactive decay to the midpoint of the month of collection. Unfortunately, the bulk of the air filter samples collected at SPO during 1993 have been "lost" during transit to EML.

Table 1. Monthly Surface Air Concentrations of Radionuclides at BRW, MLO, SMO, and SPO during 1993

Site	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					Nuclide: C	Samma (cpn	n m <sup>-3</sup> )					
BRW	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
MLO	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
SMO	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	*	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
SPO	< 0.01	*	*	*	*	*	*	*	*	*	< 0.01	*
					Nuclide:	<sup>7</sup> Be (mBq i	$m^{-3}$ )					
BRW	1.4	1.4	1.6	2.3	1.8	0.6	0.8a	0.5	0.9	1.6	1.7	2.5
MLO	4.7	8.0	7.5	7.1	7.2	7.1	7.0	5.5	5.0	6.0	7.2	7.0
SMO	1.3	2.2	1.3	0.8	2.0	2.5	*	2.5	3.2	3.7	2.5	2.0
SPO	6.8	*	*	*	*	*	*	*	*	*	5.9	*
					Nuclide:	95Zr (mBq	$m^{-3}$ )					
BRW	< 6.2	<3.3	<4.4	<1.1	<37.	< 5.1	<29.	< 3.6	< 5.1	<7.3	< 5.7	<13.
MLO	< 5.4	< 8.9	<12.	< 6.9	<12.	< 2.5	<45.	<19.	<14.	< 2.7	<11.	<14.
SMO	< 7.6	< 6.5	<7.7	<9.3	<20.	<14.	*	<4.6	< 5.7	<4.8	<4.9	<4.7
SPO	<30.	*	*	*	*	*	*	*	*	*	<11.	*

Table 1. Monthly Surface Air Concentrations of Radionuclides at BRW, MLO, SMO, and SPO during 1993—Continued

Site	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					Nuclide: 1	.37Cs (mBq	m <sup>-3</sup> )					
BRW	<1.3	< 0.9	<1.1	0.9a	<1.9	< 0.5	< 0.6	< 0.7	<1.1	< 2.0	< 0.6	<1.7
MLO	<1.2	<2.1	< 2.0	<2.0	<1.4	< 0.8	<4.1	< 3.4	< 2.5	< 0.8	<3.1	< 3.6
SMO	< 2.2	< 2.3	<1.4	<1.6	<1.3	<1.6	*	< 0.9	<1.3	<1.2	<1.6	<1.8
SPO	<1.2	*	*	*	*	*	*	*	*	*	< 2.0	*
					Nuclide: 1	44Ce (mBq	$m^{-3}$ )					
BRW	<5.5	<3.3	<4.6	<2.1	<11.	<2.1	<3.6	< 2.5	<4.5	< 9.0	< 3.0	<9.2
MLO	< 5.3	< 9.9	< 8.0	< 8.1	< 6.7	<3.4	<18.	<18.	<12.	< 3.1	<13.	<18.
SMO	< 9.3	<11.	< 6.5	< 6.9	<7.2	< 8.2	*	< 3.9	< 5.4	< 5.8	< 6.6	< 7.6
SPO	< 5.8	*	*	*	*	*	*	*	*	*	< 9.4	*
					Nuclide: 2	210 <sub>Pb</sub> (mBq	$m^{-3}$ )					
BRW	0.78	0.80	0.67	0.38	0.26	0.05	0.11	0.06	0.09	0.23	0.35	0.59
MLO	$0.17^{a}$	0.31	0.49	0.54	0.43	0.49	$0.27^{a}$	0.18	0.23	0.26	0.22	0.21
SMO	$0.03^{a}$	$0.05^{a}$	$0.02^{b}$	$0.02^{b}$	$0.05^{a}$	$0.04^{a}$	*	$0.05^{c}$	0.09	0.08	0.08	0.05
SPO	$0.03^{a}$	*	*	*	*	*	*	*	*	*	0.03 <sup>a</sup>	*

<sup>\*</sup>No data

### DISSCUSSION

During 1993 there was one reported significant release of anthropogenic radionuclides into the atmosphere. On April 6, 1993, radioactivity was accidentally released into the atmosphere during an explosion and fire at a reprocess-ing plant in the Tomsk-7 military nuclear complex located 16 km north of the Siberian city of Tomsk. Details about the release of nuclear materials from this accident and the atmospheric transport and detection of the debris have been previously reported [Lee et al., 1993; Larsen et al., 1994]. We suggest that the detection of <sup>137</sup>Cs at BRW during April (see Table 1) represents traces of the Tomsk-7 debris released during this accident [Larsen et al.,

The seasonal cycles of <sup>7</sup>Be and <sup>210</sup>Pb continue to follow those observed in previous years [Feely et al., 1989; Larsen and Feely, 1986].

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Uncertainty is < 20% except:

aUncertainty is between 20% and 50% bUncertainty is between 50% and 100%

<sup>&</sup>lt;sup>c</sup>Uncertainty is > 100%